Remarks: Examination Report

1. Claims 1-21 are pending.

2. Claims 1-21 were rejected under 35 U.S.C. 103(a) as being unpatentable over Proakis (U.S. 5,844,951) in view of Thomas (U.S. 6,141,393).

3. With regard to Independent Claim 1, the Examiner states that Proakis teaches transforming an input signal into a plurality of spectral components and Thomas teaches providing for computation of a set of weights and combining weighted components by a receiver having a **plurality of receiving antennas**.

4. With regard to Independent Claim 4, the Examiner states that Proakis teaches transforming an input signal into a plurality of spectral components and Thomas teaches separating interfering signals in a receiver having a **plurality of receiving antennas**.

5. With regard to Independent Claim 7, the Examiner states that Proakis teaches transforming an input signal into a plurality of diversity (i.e., spectral) components and Thomas teaches providing for separation of interfering signals by processing the diversity components in a receiver having a **plurality of receiving antennas**.

6. With regard to Independent Claim 11, the Examiner states that Proakis teaches an apparatus capable of spatially separating a plurality of interfering signals including a diversity receiver adapted to separate at least one received signal into a plurality of frequency components and Thomas teaches weighting and combining frequency components to cancel interference in a receiver having a **plurality of receiving antennas**.

7. Accordingly, Independent Claims 1, 4, 7, and 11 were amended to distinguish the invention from the prior art. In particular, language was added to the claims that clarifies that the invention pertains to spatial demultiplexing across non-spatial diversity parameters. That is, **the claimed invention does not require a plurality of receiving antennas to achieve spatial demultiplexing**.

8. Applicant submits that the above-recited step of providing for combining <u>across</u> the weighted spectral components to cancel co-channel interference in the Independent Claim 1 (and hence in the dependent claims 2-3) presents a novel method that the cited combination of prior-art references neither describe nor anticipate.

9. Applicant submits that the above-recited step of providing for separation of the interfering signals by processing either or both the amplitude variations and the phase variations <u>across</u> the plurality of spectral components in the Independent Claim 4 (and hence in the dependent claims 5-6) presents a novel method that the cited combination of prior-art references neither describe nor anticipate.

10. Applicant submits that the above-recited step of providing for separation of the interfering signals by processing either or both the amplitude variations and the phase variations <u>across</u> the plurality of <u>non-spatial</u> diversity components in the Independent Claim 7 (and hence in the dependent claims 8-10) presents a novel method that the cited combination of prior-art references neither describe nor anticipate.

11. Applicant submits that the above-recited <u>frequency-domain</u> spatial interferometry demultiplexer adapted to provide <u>frequency-domain</u> processing to the plurality of frequency components to separate at least one information signal from at least one interfering signal in the Independent Claim 11 (and hence in the dependent claim 12) presents a novel structure that the cited combination of prior-art references neither describe nor anticipate.

12. In particular, the clarification stating that spatial demultiplexing and interference cancellation are performed across non-spatial (e.g., spectral, or frequency-domain) diversity components (such as recited on Page 6, line 1 to Page 7, line 9, and illustrated in FIGs. 1 and 2 in the present application) distinguishes the claimed invention over the combination of Proakis and Thomas, which separately (and together) employ spatial diversity (i.e., **a plurality of receiver antennas**) in order to perform spatial demultiplexing.

13. Since the claimed invention performs spatial demultiplexing across non-spatial (e.g., spectral) diversity components, the invention does not require a plurality of receiver antennas to achieve spatial demultiplexing. Rather, the invention may employ only a single receiver antenna, such as shown in FIGs. 1 and 2. Thus, the recited invention also distinguishes itself from the cited prior-art references by not requiring the recitation of a plurality of receiving antennas.

14. **The cited and relied-upon references Proakis and Thomas Thomas fail to teach processing non-spatial signal components to achieve spatial demultiplexing, such as recited by the claimed invention. Thus, Proakis and Thomas recite the need for antenna arrays to perform spatial demultiplexing.**

Proakis shows a **plurality of receiving antennas** (FIG. 1) that are employed to perform diversity combining and equalization. Unlike conventional antenna array beamforming, Proakis describes an antenna array beamforming system that performs joint diversity combining and equalization (col. 2, lines 50-60). Specifically, Proakis teaches that spectral components are combined in an equalization process (col. 7, lines 30-35) rather than in a beam-forming (i.e., spatial demultiplexing) process. Beamforming depends only on the angle of arrival of received signals rather than the spectral components (col. 7, line 65 to col. 8, line 3).

Thomas shows a **plurality of receiving antennas** (FIGs. 1, 2, and 3) that are employed to perform equalization and spatial demultiplexing. For example, Thomas teaches to

separate a received signal into a plurality of slow-fading spectral components prior to performing spatial demultiplexing (i.e., beamforming). Separating a signal into narrowband spectral components converts the channel response from a fast frequency-selective response to a slow fading response, which presents simpler equalization and spatial processing in an antenna array (col. 3, lines 19-65). Thus, Thomas teaches methods that are particular to receivers employing a **plurality of antennas** (col. 4, lines 50-55). Thomas teaches that a single antenna can be used for equalization, but **a plurality of receiving antennas** is needed to separate interfering signals from more than one transmitting device (col. 5, lines 24-33, and col. 5, lines 39-44). Thus, Thomas teaches to use **a plurality of receiving antennas** for recovering all of the information transmitted by multiple interfering transmitting devices (col. 5, lines 44-47).

15. **The combination of cited and relied-upon references Proakis and Thomas fail to teach processing non-spatial signal components to achieve spatial demultiplexing, such as recited by the claimed invention.**

16. The prior-art references fail to teach or suggest performing spatial demultiplexing across non-spatial (e.g., spectral) diversity components. Rather than suggest the desirability of being able to perform spatial demultiplexing with only a single antenna, the combination of Proakis and Thomas teaches spatial demultiplexing across spatial signal components (which requires that those signals originate from multiple receiver antennas).

17. As discussed in MPEP 2143.01, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine reference teachings.

    Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. In re Fine , 837 F.2d 1071, 5

USPQ2d 1596 (Fed. Cir. 1988); In re Jones , 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

18. One of the relied upon references, Thomas, teaches away from the invention.

19. Thomas teaches that whereas a single antenna can be used for equalization, a **plurality of receiving antennas** is needed to separate interfering signals from more than one transmitting device (col. 5, lines 24-33, and col. 5, lines 39-44).

    Ascertaining the differences between the prior art and the claims at issue requires interpreting the claim language, and considering both the invention and the prior art references as a whole. As stated in MPEP 2141.02, prior art must be considered in its entirety, including disclosures that teach away from the claims.

20. As detailed above, the cited art describes a different type of signal processing to that claimed by the present invention. Although different to the present invention, such signal-processing protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the Proakis and Thomas for equalizing, diversity combining, and spatial demultiplexing signals from multi-antenna receivers, and there is no teaching in the prior art to change the type of signal-processing protocols provided so as to resemble or reflect that of the present invention. As there is no motivation to change, no teaching to change, and no description of how any change may be made to achieve spatial demultiplexing by processing non-spatial signal components, such as described in the methods and apparatus disclosed in Applicant's invention, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

21. With regard to Independent Claims 13 and 15, the Examiner states that Proakis teaches a method of producing diversity-encoded spread spectrum signals by generating a wideband signal and impressing an information signal on the wideband signal to produce at least one spread-spectrum signal (col. 2, line 45- col. 3, line 66;

col. 12, line 43- col. 13, line 46) and Thomas teaches providing for duplicating and diversity-encoding the spread-spectrum signal (col. 4, line 40- col. 5, line 54; col. 7, line 3- col. 8, line 25; col. 9, line 38- col. 10, line 55).

22. The invention recited in Independent Claims 13 and 15 recite "a method of producing diversity-encoded spread-spectrum signals," whereas Proakis and Thomas both disclose only receiver side processing of wideband signals. For example, Proakis recites a multi-channel receiver (such as in col. 2, lines 46-48, and col. 12, lines 56-57) and Thomas recites receiving antennas (such as in col. 4, lines 50-55). Thus, the steps of providing for generation of at least one wideband electromagnetic signal and providing for impressing an information signal onto the at least one wideband signal to produce at least one spread-spectrum signal, such as recited in Claim 13, are absent in the cited references. Similarly, Thomas fails to show a step of "providing for diversity-encoding of at least one of the spread-spectrum signals" since such an activity would be inappropriate in a receiver, since the function of a receiver is to perform diversity decoding as part of a diversity-combining operation.

23. Furthermore, the method of <u>providing for a correlation process at a receiver to correlate the plurality of spread-spectrum signals for recovering the information signal</u>, such as recited in Claim 13, and the method of providing for generating at least one decoding signal <u>for correlating with the at least one information-bearing wideband radio signal at a receiver to recover at least one information signal</u> recited in Claim 15 are substantially different than the receiver techniques described by Proakis and Thomas.

24. In particular, the correlation process recited in the claimed invention employs the received signals to recover modulated information. Thus, rather than requiring diversity combining and equalization to compensate for the channel response (such as recited in Proakis, col. 2, line 56- col. 3, line 14, and in Thomas, col. 4, lines 40-55), the invention employs a plurality of duplicate spread-spectrum signals that experience substantially identical channel conditions. Correlations between the duplicate spread-

spectrum signals provide a means to recover modulated information without having to compensate for channel distortions. Conversely, Thomas requires calculating the channel frequency response prior to equalization or combining (col. 4, lines 40-50) whereas the claimed invention recites correlating two or more signals (which have substantially the same frequency response) in order to provide for information recovery **without requiring diversity combining and equalization**.

25. Finally, the methods recited in Independent Claims 13 and 15 do not require a receiver array to perform spatial demultiplexing, whereas the methods described by both Proakis and Thomas require receiver arrays, such as noted previously.

26. With regard to Independent Claims 17 and 18, the Examiner states that Proakis discloses a transmitter comprising a wideband signal generator, an information signal generator and a modulator (col. 2, line 45- col. 3, line 66; col. 12, line 43- col. 13, line 46) and Thomas discloses a method of employing a plurality of receiving antennas to receive data symbols and pilot signals, computing a channel transfer function, and providing for weighting and combining the received signals based on the channel transfer function (col. 4, line 40- col. 5, line 54; col. 7, line 3- col. 8, line 25; col. 9, line 38- col. 10, line 55).

27. The invention recited in Independent Claims 17 recites a transmitter including "a diversity processor adapted to duplicate the at least one spread-spectrum signal to provide a plurality of duplicate spread-spectrum signals and adjust at least one diversity parameter of at least one of the duplicate spread-spectrum signals to produce at least one adjusted signal and at least one unadjusted signal for enabling separation of the at least one adjusted signal from the at least one unadjusted signal," and the invention recited in Independent Claim 18 recites a transmitter including "a diversity processor adapted to adjust at least one diversity parameter of at least one of the at least one spread-spectrum signal and the at least one wideband signal to enable separation of the at least one spread-spectrum signal from the at least one at least one wideband signal," whereas Proakis and Thomas both disclose only receiver-side

processing of wideband signals. For example, Proakis recites a multi-channel receiver (such as in col. 2, lines 46-48, and col. 12, lines 56-57) and Thomas recites receiving antennas (such as in col. 4, lines 50-55). Thus, the wideband-signal generator, the modulator, and the diversity processor represent novel structure that is not present in the cited references.

28. Furthermore, the function of the diversity processor recited in Claims 17 and 18 would be inappropriate in a receiver described in both Proakis and Thomas. The function of the Proakis and Thomas receivers include diversity-**combining** operations (e.g., in Proakis, col. 2, lines 56-60, and in Thomas, col. 4 lines 50-55) to combine like signals rather than adjusting signal diversity parameters to facilitate **separation** of like signals. Accordingly, the cited and relied upon combination of references Proakis and Thomas teach away from the claimed invention, which makes the claimed invention non-obvious and patentatable under U.S.C. 103.

29. Finally, the methods recited in Independent Claims 17 and 18 produce signals that do not require a receiver array to perform spatial demultiplexing, whereas the methods described by both Proakis and Thomas require receiver arrays, such as noted previously.

30. With regard to Independent Claim 19, the Examiner states that Proakis discloses a transmitter comprising a wideband signal generator, an information signal generator and a modulator (col. 2, line 45- col. 3, line 66; col. 12, line 43- col. 13, line 46) and Thomas discloses a method of employing a plurality of receiving antennas to receive data symbols and pilot signals, computing a channel transfer function, and providing for weighting and combining the received signals based on the channel transfer function (col. 4, line 40- col. 5, line 54; col. 7, line 3- col. 8, line 25; col. 9, line 38- col. 10, line 55).

31. With regard to Independent Claim 20, the Examiner states that Proakis discloses a transmitter comprising a wideband signal generator, an information signal generator

and a modulator (col. 2, line 45- col. 3, line 66; col. 15, line 20- col. 16, line 61) and Thomas discloses a method of employing a plurality of receiving antennas to receive data symbols and pilot signals, computing a channel transfer function, and providing for weighting and combining the received signals based on the channel transfer function (col. 4, line 40- col. 5, line 54; col. 7, line 3- col. 8, line 25; col. 9, line 38- col. 10, line 55).

32. Applicant submits that the above recited signal correlator adapted to correlate the plurality of highly correlated signals to generate a correlation signal indicative of the information signal in the amended Independent Claim 19 and the above recited signal correlator adapted to correlate the at least one diversity-coded signal with the at least one despreading signal to generate a correlation signal indicative of the information signal in the amended Independent Claim 20 presents novel structure that the cited combination of prior-art references neither describe nor anticipate.

33. In particular, providing correlation of a plurality of received signals circumvents the need for channel equalization and diversity combining described in both Proakis (col. 2, lines 46-50) and Thomas (col. 4, lines 50-55). Thus, both Proakis and Thomas teach to estimate the channel, and then correct (i.e., equalize) the channel distortion. Conversely, the claimed invention employs a plurality of signals transmitted through substantially the same channel, and thus the received signals have similar channel distortions. The received signals are then correlated with each other to recover the modulated information without requiring channel equalization.

34. Since the claimed invention performs spatial demultiplexing by correlating received signals via non-spatial (e.g., spectral, temporal, etc.) diversity components, the invention does not require a plurality of receiver antennas to achieve spatial demultiplexing. Similarly, the invention may use fewer receiver antennas to spatially demultiplex a given number of signals than in conventional multiple-antenna receivers (such as described on page 9, lines 3-6 of the Specification), whereas the

maximum number of interfering signals that prior-art antenna systems can process cannot exceed the number of receiver antennas.

35. Proakis and Thomas both require a plurality of receiver antennas to perform spatial demultiplexing. Since Proakis and Thomas employ only spatial components (i.e., signals from multiple antennas) for spatial demultiplexing, the maximum number of interfering signals that these receivers can process equals the number of receiver antennas,

36. With regard to Independent Claim 21, the recited nonlinear processor adapted to apply a nonlinear process to at least one signal of the algebraically unique combination of information signals to increase the number of the at least one algebraically unique combination presents novel structure that the prior art references fail to describe.

37. In particular, by applying nonlinear processing to received signals, it is possible to increase the number of algebraically unique combinations of received signals, which then increases the number of spatial channels that can be processed. This is a substantial improvement over conventional spatial processing, such as described in Proakis and Thomas, which is limited by the number of receiver antennas, such as described above.

The Cited but Non-Applied References

38. These subsidiary references have been studied, but are submitted to be less relevant than the relied-upon references.

39. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objection and that the Application is now in condition to proceed to grant.

Very respectfully,

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